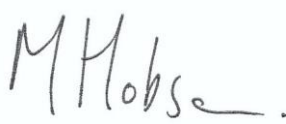


Air Quality Assessment for the proposed development at 1 Darwin Close, Reading



Report to The White Partnership
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1. Introduction

Aether has been commissioned by The White Partnership to undertake an air quality assessment for the proposed development at 1 Darwin Close, Reading. The site is currently occupied by a vacant industrial building. The development will consist of the redevelopment of the site to provide light industrial use and warehousing. Following advice from the Transport Consultants, it has been assumed that the development will not result in an increase in daily vehicular trips. In addition, there will be no air pollutant emitting on-site energy generation.

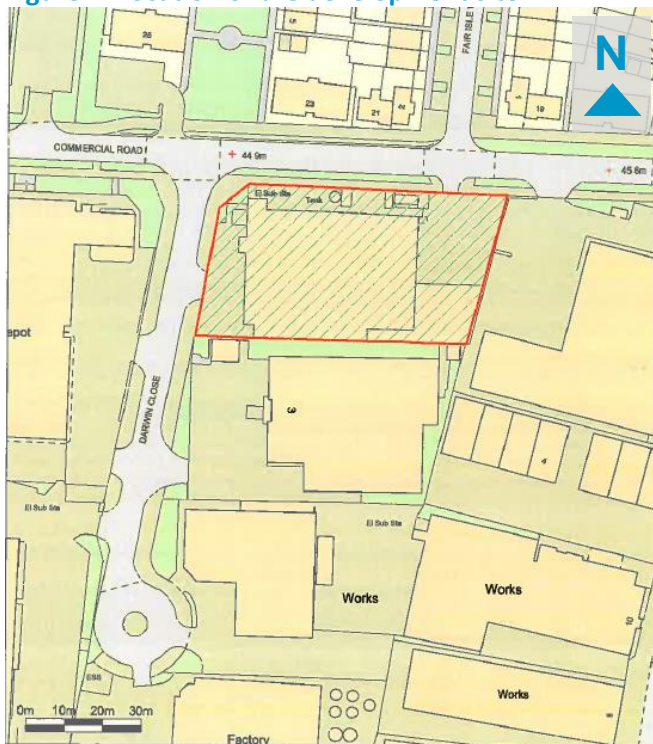
The development falls within Reading Borough Council, which suffers from elevated levels of air pollution, primarily due to high levels of traffic. It is therefore important to assess whether there will be an exceedance of the air quality objectives for particulate matter (PM₁₀) or nitrogen dioxide (NO₂) at the proposed site and then advise whether any action is required to reduce the public's exposure to air pollution. The assessment utilises ADMS-Roads, a comprehensive dispersion modelling tool for investigating air pollution problems due to small networks of roads and industrial sources.

The expected completion date of the proposed development is 2018. The assessment has therefore been completed for 2019, the expected first full year of occupation.

1.1 The Location of the Development

The proposed development is located on the corner of Darwin Close and Commercial Road in Reading (Figure 1).

Figure 1: Location of the development site



1.2 Assessment Criteria

A summary of the air quality objectives relevant to the Reading development, as set out in the UK Air Quality Strategy¹, is presented in Table 1 below.

Table 1: UK Air Quality Objectives for NO₂ and PM₁₀

Pollutant	Concentration	Measured as
Nitrogen Dioxide (NO ₂)	40 µg/m ³	Annual mean
	200 µg/m ³	Hourly mean not to be exceeded more than 18 times per year (99.8 th percentile)
Particulate Matter (PM ₁₀)	40 µg/m ³	Annual mean
	50 µg/m ³	24 hour mean not to be exceeded more than 35 times a year (90.4 th percentile)

The oxides of nitrogen (NO_x) comprise principally of nitric oxide (NO) and nitrogen dioxide (NO₂). NO₂ is a reddish brown gas (at sufficiently high concentrations) and occurs as a result of the oxidation of NO, which in turn originates from the combination of atmospheric nitrogen and oxygen during combustion processes. NO₂ can also form in the atmosphere due to a chemical reaction between NO and ozone (O₃). Health based standards for NO_x generally relate to NO₂, where acute and long-term exposure may adversely affect the respiratory system.

Particulate matter is a term used to describe all suspended solid matter, sometimes referred to as Total Suspended Particulate matter (TSP). Sources of particles in the air include road transport, power stations, quarrying, mining and agriculture. Chemical processes in the atmosphere can also lead to the formation of particles. Particulate matter with an aerodynamic diameter of less than 10 µm is the subject of health concerns because of its ability to penetrate deep within the lungs and is known in its abbreviated form as PM₁₀.

Further information on the health effects of air pollution can be found in the reports produced by the Committee on the Medical Effects of Air Pollutants².

As defined by the regulations, the air quality objectives for the protection of human health are applicable:

- Outside of buildings or other natural or man-made structures above or below ground; and
- Where members of the public are regularly present.

Using these definitions, the annual mean objectives will apply at locations where members of the public might be regularly exposed such as building façades of residential properties, schools and hospitals and will not apply at the building façades of offices or other places of work, where members

¹ The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (2007), Published by Defra in partnership with the Scottish Government, Welsh Assembly Government and Department of the Environment Northern Ireland

² <https://www.gov.uk/government/collections/comeap-reports>

of the public do not have regular access. The 24 hour objective will apply at all locations where the annual mean objective would apply together with hotels. Therefore, in this assessment, the annual mean and 24 hour mean objectives will not apply. The hourly objective will apply at all locations where members of the public could reasonably be expected to spend that amount of time. Therefore, in this assessment the hourly objective will apply at all levels of the development.

1.3 Local Air Quality Management

Local authorities are required to periodically review and assess the current and future quality of air in their areas. Where it is determined that an air quality objective is not likely to be met, the authority must designate an Air Quality Management Area (AQMA) and produce an Air Quality Action Plan (AQAP).

Reading Borough Council declared an AQMA³ in 2009 due to exceedances of the annual mean NO₂ objective. The AQMA covers all the main arterial routes in and out of Reading and the Town Centre. The proposed development site falls just outside this AQMA, between the A33 and B3031 which are included in the AQMA. An AQAP was produced in 2015⁴ which details the actions being taken to improve local air quality.

1.4 The ADMS-Roads Method

Local air quality has been assessed using ADMS-Roads, a comprehensive dispersion model that can be used to predict concentrations of pollutants in the vicinity of roads and small industrial sources. The model has been used for many years in support of planning applications for new residential/commercial developments.

ADMS-Roads is able to provide an estimate of air quality both before and after development, taking into account important input data such as background pollutant concentrations, meteorological data, traffic flows and on-site energy generation (if applicable). The model output can be verified against local monitoring data to increase the accuracy of the predicted pollutant concentrations and this approach has been followed in this assessment.

The use of dispersion modelling enables estimates of concentrations to be made at varying heights. As a result, suggestions for appropriate mitigation measures can be made where necessary, taking into consideration the identification of worst-case locations.

The most recent version of ADMS-Roads (v4.1) was issued in February 2017 and requires the following information to assess the impact at sensitive receptor locations:

- Setup: General site details and modelling options to be used;
- Source: Source dimensions and locations, release conditions, emissions;
- Meteorology: hourly meteorological data;
- Background: Background concentration data;

³ https://uk-air.defra.gov.uk/aqma/local-authorities?la_id=201

⁴ http://www.reading.gov.uk/media/4209/Air-Quality-Action-Plan/pdf/AQAP_Proposed_actions.pdf

- Grids: Type and size of grid for output; and
- Output: Output required and sources/groups to include in the calculations.

2. Methodology

2.1 Local Pollutant Concentrations

It is good practice to include up-to-date local background pollutant concentrations in the assessment model, and also to verify modelled outputs against local monitoring data where available. This section provides an overview of the local data available for use in the assessment.

Local monitoring data

Reading Borough Council has four automatic monitoring sites which monitor nitrogen dioxide (NO₂) and particulate matter (PM₁₀). Unfortunately, all of these are located more than 3.5 kilometres from the development site. NO₂ concentrations are also measured passively at diffusion tube sites across the Borough. One of these diffusion tube sites lies within 550 m of the development site. Details of this site are given in Table 2. As none of the automatic monitoring sites are located within close proximity to the development site, no nearby PM₁₀ monitoring is available.

Monitoring results have been taken from the Council's latest Annual Status Report (ASR)⁵.

Table 2: Monitoring sites within 550 m of the Darwin Close development

Site Name	Site Type	Pollutant(s)	Grid Reference	Distance to Kerb (m)	Approx. Distance to development site (m)
495 Basingstoke Road	R	NO ₂	471709, 170043	8	520

Note: R = roadside

The diffusion tubes were analysed by Gradko International Ltd, who participate in the Proficiency scheme⁶. Whilst diffusion tubes provide an indicative estimate of pollutant concentrations, they tend to under or over read. The data is therefore corrected using a bias adjustment factor. There are two types of bias adjustment factor – local and national. The local factor is derived from co-locating diffusion tubes (usually in triplicate) with automatic monitors, whereas the national factor is obtained from the average bias from all local authorities using the same laboratory. Reading Borough Council has applied a national bias adjustment factor (1.03) to their 2016 diffusion tube results.

Monitoring results are presented in Table 3. The data shows that there were no exceedances of the annual mean NO₂ objective at the 495 Basingstoke Road diffusion tube site between 2014 and 2016. Diffusion tubes do not provide information on hourly exceedances, but research⁷ identified a relationship between the annual and 1 hour mean objective, such that exceedances of the latter were

⁵ At the time of completing this report, the 2017 ASR was not publicly available. The 2016 ASR can be found at:

http://www.reading.gov.uk/media/6388/Air-Quality-Annual-Status-Report/pdf/Reading_Annual_Status_Report_2016.pdf

⁶ This is a national QA/ QC scheme.

⁷ As described in Box 5.2 of LAQM Technical Guidance (TG16).

considered unlikely where the annual mean was below 60 µg/m³. Therefore, it is considered highly unlikely that the 1 hour mean objective has been exceeded in recent years.

Table 3: Monitoring results for sites close to the proposed development site, 2014-2016

Objective	Site Name	2014	2015	2016
Annual mean NO ₂ (µg/m ³)	495 Basingstoke Road	34	31	33

Background mapped data

Background pollutant concentration maps are available from the Defra LAQM website⁸ and data has been extracted for Reading for this assessment. These 2013 baseline, 1 kilometre grid resolution maps are derived from a complex modelling exercise that takes into account emissions inventories and measurements of ambient air pollution from both automated and non-automated sites.

The estimated mapped background NO_x, NO₂ and PM₁₀ concentrations around the development site are 31.5 µg/m³, 20.9 µg/m³ and 15.7 µg/m³ respectively in 2016 (the baseline year used in the assessment). The background maps also provide projections to future years. For 2019 (the first estimated year of occupation), the concentrations obtained for the same pollutants are 27.9 µg/m³, 18.9 µg/m³ and 15.3 µg/m³ respectively.

Due to the lack of a nearby urban background monitoring site, the 2016 mapped background concentrations have been used in this assessment. To provide a conservative estimate, the projected improvements in background air quality by 2019 have not been used in the dispersion modelling.

2.2 Traffic data

Annual average daily flow (AADF) count data for 2016 has been obtained for Basingstoke Road (B3031) from the Department of Transport (DfT) AADF data for minor roads⁹. In the absence of any other data being available for the minor roads, estimates are based upon average values for an 'urban minor road, South' from the DfT National Road Traffic Survey, 2017¹⁰. Darwin Close and Commercial Road are minor roads and therefore no specific traffic data is available for these roads. Therefore, there will be uncertainty in the model input. All roads within 200 metres of the modelled receptors have been included in the assessment. The values are shown in Appendix B.

For the purpose of this assessment, the RTF¹¹ model has been utilised to project traffic growth. It has been assumed that traffic on local roads will increase by 3.9 % between 2016 and 2019.

⁸ <http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html>

⁹ <https://data.gov.uk/dataset/gb-road-traffic-counts/resource/35fa861c-e08e-46f6-94f3-542241d92bde>

¹⁰ <http://www.dft.gov.uk/statistics/series/traffic/>

¹¹ <http://laqm.defra.gov.uk/documents/RTF-Automated-Traffic-Growth-Calculator-v3-1.xls>

The Transport Consultants have advised that due to the small scale nature of the scheme and the relatively minor reductions in traffic flows expected, traffic surveys have not been undertaken¹². Therefore, it has been assumed that the development will not result in an increase in daily vehicular trips to and from the site. Results (Section 3 of this report) therefore refer to concentrations modelled in 2019 regardless of whether the development takes place or not.

In the absence of any other data being available, average speeds on local roads have been assumed based on the speed limit.

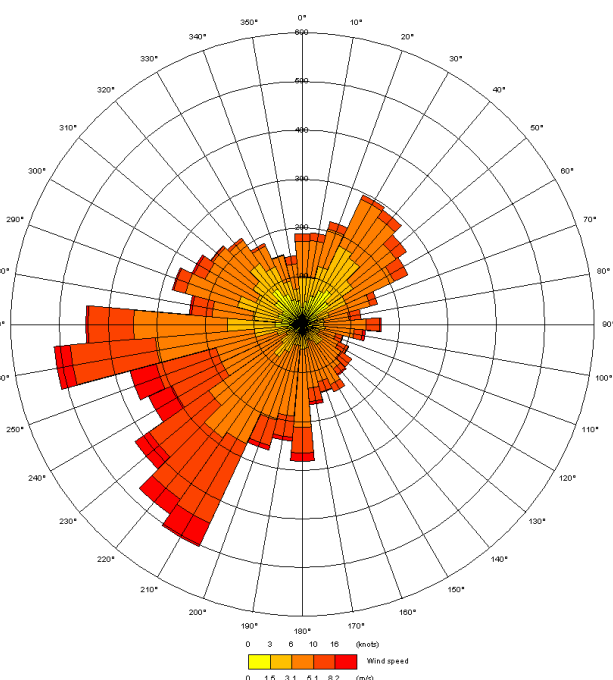
Queuing Traffic

Special consideration has been given to notable junctions modelled in this assessment. CERC note 60¹³ has been used for estimating emissions from queuing traffic. This defines a representative AADT for queuing traffic to be 30,000 at 5 kph, assuming an average vehicle length of 4 m. These figures, along with the traffic composition of the corresponding roads were then input into the Emission Factor Toolkit (EFT)¹⁴ to calculate emission rates. The emission rates were then used within the dispersion model as separate road sources of pre-defined length, representing each queue with time-varying emission profiles applied to represent busy periods.

2.3 Model input data

Hourly meteorological data from Heathrow for 2016 has been used in the model. The wind-rose diagram (Figure 2) presents this below.

Figure 2: Wind-rose diagram for Heathrow meteorological data, 2016

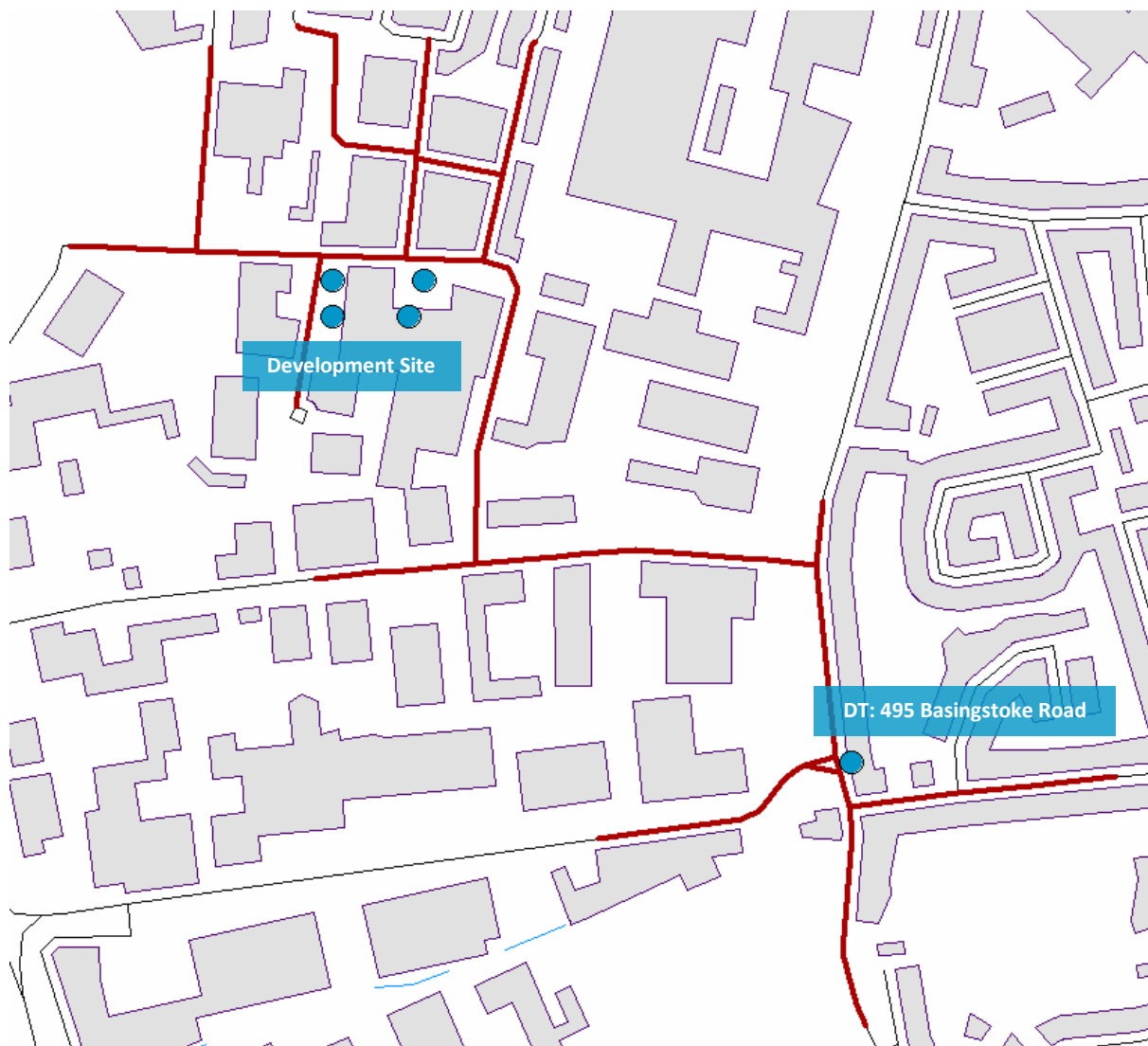


¹² Confirmed via email Joanne Jones, Associate Planner Pegasus Group 06/09/2017

¹³ Cambridge Environmental Research Consultants Ltd, Modelling Queuing Traffic – note 60, 20th August 2004

¹⁴ Latest version 7.0, <http://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html>

Figure 3: Road sources and receptors



Contains Ordnance Survey data © Crown copyright and database right [2017]

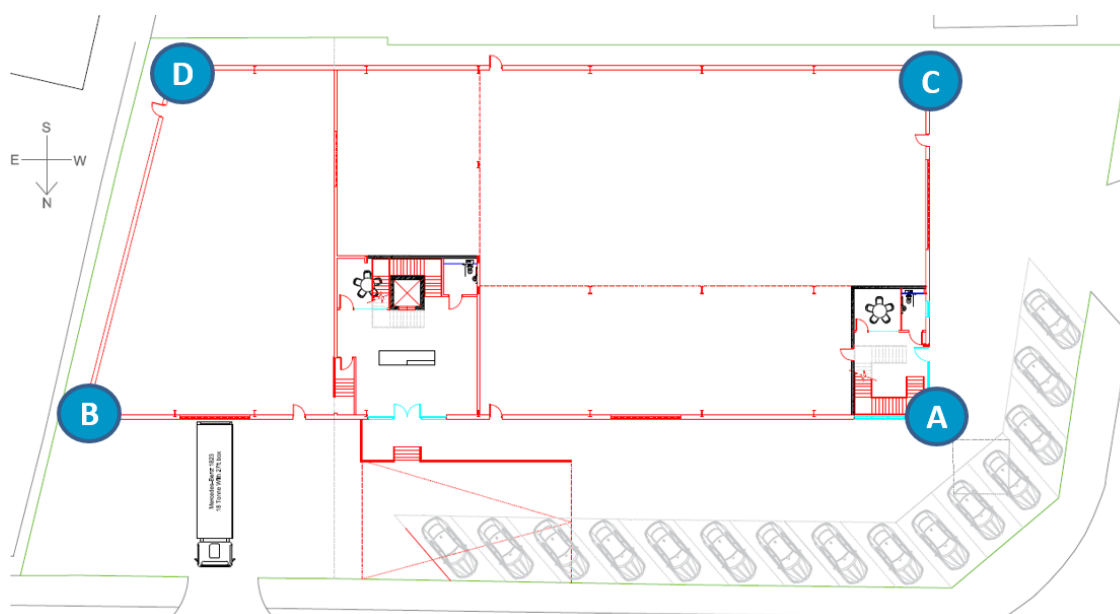
ArcMap software has been used to model the road source locations (red lines) that are within 200 metres of the receptor locations (blue circles). This data can then be automatically uploaded to ADMS-Roads. This generates an accurate representation of the surrounding area to be assessed in the model in terms of the length of roads and distances between sources and receptors. This is shown in [Figure 3](#) above. It is assumed that the contribution of other sources to NO₂ and PM₁₀ is included in the background concentrations.

Four sensitive ground floor receptor locations have been selected for the assessment:

- A. North west corner of the development, located closest to Darwin Close and Commercial Road
- B. North east corner of the development
- C. South west corner of the development,
- D. South east corner of the development, representing the drop off in pollutant concentrations with distance from the roads

These sites have been chosen to reflect the extremities of the site and their proximity to road traffic sources. The architect's plans (Figure 4) show the development site in more detail with receptor locations highlighted (blue circles). An assessment is made for the receptors at ground floor level. Exposure has been assumed to be represented at the mid-point of the floor.

Figure 4 The location of the receptors used in the modelling



2.4 Conversion of NO_x to NO₂

Recent evidence shows that the proportion of primary NO₂ in vehicle exhaust has increased¹⁵. This means that the relationship between NO_x and NO₂ at the roadside has changed from that currently used in the ADMS model. A NO_x to NO₂ calculator (Published in June 2016)¹⁶ has therefore been developed and has been used in conjunction with the ADMS model to obtain a more accurate picture of NO₂ concentrations.

2.5 Model Verification

Model verification refers to checks that are carried out on model performance at a local level. This involves the comparison of predicted versus measured concentrations. Where there is a disparity, the first step is to check the input data and the model parameters in order to minimise the errors. If required, the second step will be to determine an appropriate adjustment factor that can be applied. In the case of NO₂, the model should be verified for NO_x as the initial step and should be carried out separately for the background contribution and the source (i.e. road traffic). Once the NO_x has been verified and adjusted as necessary, a final check should be made against the measured NO₂ concentration.

¹⁵ <http://uk-air.defra.gov.uk/assets/documents/reports/ageg/primary-no-trends.pdf>

¹⁶ <http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOXNO2calc>

For this project, modelled annual mean road-NO_x estimates have been verified against the concentrations measured at the 495 Basingstoke Road diffusion tube site (see Appendix A). This site was selected as it is the monitoring site located nearest to the development. Ideally three verification sites would have been used, but no other sites were deemed suitable due to their distance from the development site.

The adjustment factor determined for annual mean NO_x concentrations was also applied to the modelled annual mean PM₁₀ concentrations. This was done as no PM₁₀ monitoring data that is representative of the development site is available, and this approach was considered more appropriate than not applying any adjustment¹⁷.

3. Results

3.1 Results of the Dispersion Modelling

Table 4 below provides the estimated pollutant concentrations in the base year (2016) and the development year (2019) regardless of whether the development takes place¹⁸. Given the inherent uncertainties in the modelling, background pollutant concentrations and vehicle fleet emission factors have been maintained at 2016 levels in the development year scenario to provide a conservative estimate. Traffic growth has been predicted using the RTF calculator.

Table 4: Estimated pollutant concentrations in the base year (2016) and the development year (2019) (µg/m³)

Receptor	Annual mean NO ₂ concentration (µg /m ³)		Annual mean PM ₁₀ concentration (µg /m ³)		NO ₂ Change	PM ₁₀ Change
	2016	2019	2016	2019		
A	21.8	21.9	15.9	15.9	<0.1	<0.1
B	21.6	21.7	15.8	15.8	<0.1	<0.1
C	21.6	21.6	15.8	15.8	<0.1	<0.1
D	21.3	21.3	15.8	15.8	<0.1	<0.1

In the base year scenario, the model predicts annual mean NO₂ concentrations to be below (by > 40 %) the annual mean objective at all locations. The worst-case location is identified as receptor A, which is located closest to Darwin Close and Commercial Road, where roadside concentrations will be maximised. Concentrations have been modelled at ground floor level; it can be assumed that concentrations at upper floors would be lower as background and road side concentrations are likely to decrease with height.

¹⁷ This is in accordance with Paragraph 7.528 of LAQM TG(16), which states that in the absence of any PM₁₀ data for verification, it may be appropriate to apply the road NO_x adjustment to the modelled road PM₁₀.

¹⁸ The development is not expected to result in any increase in vehicular trips and no air pollutant emitting on-site energy generation is planned.

The estimated annual mean NO₂ concentrations at the development site are reasonable when compared to the data collected at the 495 Basingstoke Road diffusion tube monitoring site. The diffusion tube site is located near to the B3031, which has much higher traffic flows compared to minor roads (see Appendix B). Therefore, lower concentrations are expected at the development site.

The Guidance states that authorities may assume exceedances of the hourly mean objective are only likely to occur where annual mean concentrations are 60 µg/m³ or above. Therefore, it is considered highly unlikely that this objective will be exceeded at any of the receptors.

The model has also been run for a future year scenario taking into account predicted increases to general traffic levels on local roads. The results indicate that annual mean NO₂ concentrations would change by < 0.1 µg/m³ at all locations.

The model estimates no exceedance against the annual mean PM₁₀ objective. Potential exceedances of the daily mean PM₁₀ objective can be estimated based on the annual mean¹⁹, such that:

$$\text{No. 24 - hour mean exceedances} = -18.5 + 0.00145 \times \text{Annual Mean}^3 + \left(\frac{206}{\text{Annual Mean}} \right)$$

On this basis, it is estimated that in 2019 there will be no exceedances of the daily mean PM₁₀ limit value.

3.2 Mitigation Measures

Based on the ADMS results, there is no specific requirement for mitigation as concentrations are estimated to be below all the objective levels.

However, it is widely acknowledged that there is no safe level of exposure to air pollution²⁰, and as such, the developer is further encouraged to consider further mitigation measures in order to minimise the use of private vehicles. Such measures include: providing secure and covered cycle storage, promoting car share schemes and installing electric charging points.

4. Summary and Conclusions

An air quality assessment has been undertaken for a proposed industrial development at 1 Darwin Close, Reading. Reading Borough Council has declared an Air Quality Management Area (AQMA) due to exceedances of the annual mean nitrogen dioxide (NO₂) objective. The proposed development lies on the border of this AQMA between the A33 and B3031.

A conservative approach has been taken in that no improvement in the pollutant background concentrations or road transport emission factors has been assumed between the base year (2016)

¹⁹ Paragraph 7.92 of LAQM TG(16)

²⁰ <https://www.rcplondon.ac.uk/projects/outputs/every-breath-we-take-lifelong-impact-air-pollution>

and the first year of occupation (2019). With expected improvements to the traffic fleet, improvements in pollutant concentrations may however materialise.

An air quality assessment has been carried out using the ADMS-Roads dispersion model to determine the impact of emissions from road traffic on sensitive receptors. Predicted concentrations have been compared with the air quality objectives. The results of the assessment indicate that annual mean NO₂ and particulate matter (PM₁₀) concentrations are below the objective in the base year and development year scenario. Based on the evidence it is also estimated that there will be no exceedances of either short term objective for NO₂ or PM₁₀. Therefore, no mitigation is required as the air quality objectives are predicted to be met. Instead other measures such as providing secure and covered cycle storage, car share schemes, and installing an electric charging point, should be considered to reduce the emissions arising from the development. In addition, the developer is encouraged to refer to the IAQM's 'Guidance on the assessment of dust from demolition and construction' to minimise the impact of the construction demolition phase on local air quality.

Appendix A – Model Verification

In order to verify modelled pollutant concentrations generated in the assessment, the model has been run to predict the annual mean road-NO_x concentration during 2016 at the 495 Basingstoke Road diffusion tube site described in

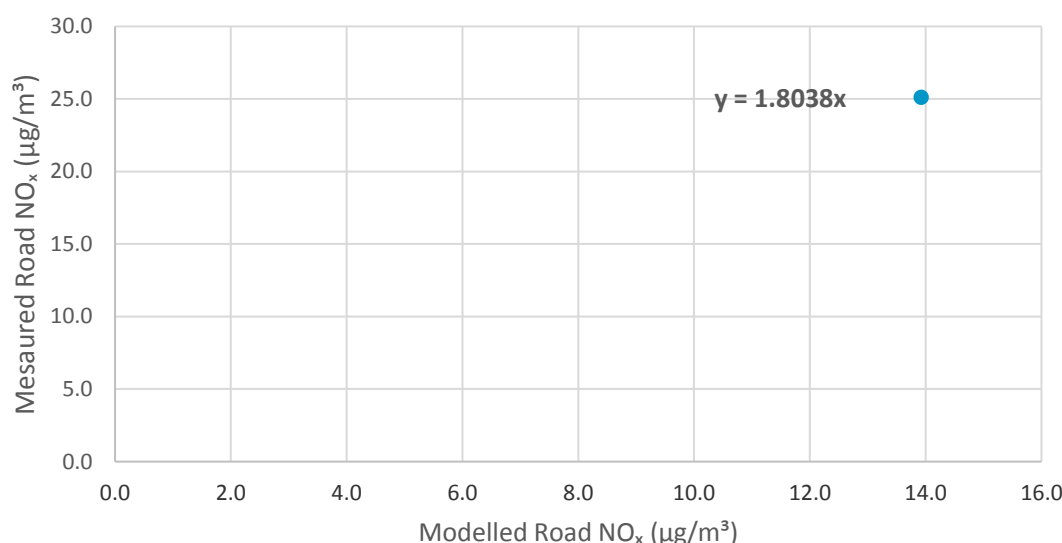
Table 2.

The model output of road-NO_x has been compared with the 'measured' road-NO_x. Measured NO_x for the monitoring sites was calculated using the NO_x to NO₂ calculator¹⁶.

A primary adjustment factor was determined to convert between the 'measured' road contribution and the model derived road contribution (Figure A.1). This factor was then applied to the modelled road-NO_x concentration for each receptor to provide adjusted modelled road-NO_x concentrations. Total NO₂ concentrations were then determined by combining the adjusted modelled road-NO_x concentrations with the 2016 background NO₂ concentration.

The results imply that the model was under-predicting the road-NO_x contribution. This is a common experience with ADMS and most other models.

Figure A.1: Comparison of Measured road-NO_x to unadjusted modelled road-NO_x concentrations



RMSE

The root mean square error (RMSE) is used to define the average error or uncertainty of the model. The following RMSE value has been calculated:

NO₂: 5.21

If the RMSE values are higher than ±25 % of the objective being assessed, it is recommended that the model inputs and verification should be revisited in order to make improvements. In this case the model is being assessed against the annual mean objectives, which is 40 µg/m³ for NO₂. RMSE values of less than 10 µg/m³ is obtained and therefore the model behaviour is acceptable.

Appendix B – Traffic Data

Table B.1: Traffic data for 2016 (and prediction for 2019)

Road links	Annual Average Daily Traffic (AADT)	% Heavy Duty Vehicles (HDV)	Speed (kph)
B3031	15,116 (15,710)	5.8	48.3
Minor Roads	2,400 (2,494)	2.0	48.3
Traffic queue B3031	30,000	5.8	5.0



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